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measuring results is less than 2 percent of full scale.

[59 FR 31335, June 17, 1994. Redesignated and amended at 63 FR 56995, 57011, Oct. 23, 1998]

§ 89.315 Analyzer bench checks.

(a) Prior to initial use and after major repairs verify that each analyzer complies with the specifications given in Table 3 in appendix A of this subpart.

(b) If a stainless steel NO₂ to NO converter is used, condition all new or replacement converters. The conditioning consists of either purging the converter with air for a minimum of 4 hours or until the converter efficiency is greater than 90 percent. The converter must be at operational temperature while purging. Do not use this procedure prior to checking converter efficiency on in-use converters.

[59 FR 31335, June 17, 1994. Redesignated at 63 FR 56995, Oct. 23, 1998]

§ 89.316 Analyzer leakage and response time.

(a) *Vacuum side leak check.* (1) Any location within the analysis system where a vacuum leak could affect the test results must be checked.

(2) The maximum allowable leakage rate on the vacuum side is 0.5 percent of the in-use flow rate for the portion of the system being checked. The analyzer flows and bypass flows may be used to estimate the in-use flow rates.

(3) The sample probe and the connection between the sample probe and valve V2 (see Figure 1 in appendix B of this subpart) may be excluded from the leak check.

(b) [Reserved]

(c) The response time shall be accounted for in all emission measurement and calculations.

[59 FR 31335, June 17, 1994. Redesignated and amended at 63 FR 56995, 57011, Oct. 23, 1998]

§ 89.317 NO_x converter check.

(a) Prior to its introduction into service, and monthly thereafter, the chemiluminescent oxides of nitrogen analyzer shall be checked for NO₂ to NO converter efficiency. Figure 2 in appendix B of this subpart is a reference for the following paragraphs.

(b) Follow good engineering practices for instrument start-up and operation. Adjust the analyzer to optimize performance.

(c) Zero the oxides of nitrogen analyzer with zero-grade air or zero-grade nitrogen.

(d) Connect the outlet of the NO_x generator to the sample inlet of the oxides of nitrogen analyzer which has been set to the most common operating range.

(e) Introduce into the NO_x generator analyzer-system an NO-in-nitrogen (N₂) mixture with an NO concentration equal to approximately 80 percent of the most common operating range. The NO₂ content of the gas mixture shall be less than 5 percent of the NO concentration.

(f) With the oxides of nitrogen analyzer in the NO mode, record the concentration of NO indicated by the analyzer.

(g) Turn on the NO_x generator O₂ (or air) supply and adjust the O₂ (or air) flow rate so that the NO indicated by the analyzer is about 10 percent less than indicated in paragraph (f) of this section. Record the concentration of NO in this NO+O₂ mixture.

(h) Switch the NO_x generator to the generation mode and adjust the generation rate so that the NO measured on the analyzer is 20 percent of that measured in paragraph (f) of this section. There must be at least 10 percent unreacted NO at this point. Record the concentration of residual NO.

(i) Switch the oxides of nitrogen analyzer to the NO_x mode and measure total NO_x. Record this value.

(j) Switch off the NO_x generator but maintain gas flow through the system. The oxides of nitrogen analyzer will indicate the NO_x in the NO+O₂ mixture. Record this value.

(k) Turn off the NO_x generator O₂ (or air) supply. The analyzer will now indicate the NO_x in the original NO-in-N₂ mixture. This value should be no more than 5 percent above the value indicated in paragraph (f) of this section.

[59 FR 31335, June 17, 1994. Redesignated and amended at 63 FR 56995, 57011, Oct. 23, 1998]

§ 89.318 Analyzer interference checks.

(a) Gases present in the exhaust other than the one being analyzed can

interfere with the reading in several ways. Positive interference occurs in NDIR and PMD instruments when the interfering gas gives the same effect as the gas being measured, but to a lesser degree. Negative interference occurs in NDIR instruments by the interfering gas broadening the absorption band of the measured gas and in CLD instruments by the interfering gas quenching the radiation. The interference checks described in this section are to be made initially and after any major repairs that could affect analyzer performance.

(b) *CO analyzer water and CO₂ interference checks.* Prior to its introduction into service and annually thereafter, the NDIR carbon monoxide analyzer shall be checked for response to water vapor and CO₂.

(1) Follow good engineering practices for instrument start-up and operation. Adjust the analyzer to optimize performance on the most sensitive range to be used.

(2) Zero the carbon monoxide analyzer with either zero-grade air or zero-grade nitrogen.

(3) Bubble a mixture of 3 percent CO₂ in N₂ through water at room temperature and record analyzer response.

(4) An analyzer response of more than 1 percent of full scale for ranges above

300 ppm full scale or more than 3 ppm on ranges below 300 ppm full scale requires corrective action. (Use of conditioning columns is one form of corrective action which may be taken.)

(c) *NO_x analyzer quench check.* The two gases of concern for CLD (and HCLD) analyzers are CO₂ and water vapor. Quench responses to these two gases are proportional to their concentrations and, therefore, require test techniques to determine quench at the highest expected concentrations experienced during testing.

(1) *NO_x analyzer CO₂ quench check.* A CO₂ span gas having a concentration of 80 percent to 100 percent of full scale of the maximum operating range used during testing shall be passed through the CO₂ NDIR analyzer and the value recorded as *a*. It is diluted approximately 50 percent with NO span gas and then passed through the CO₂ NDIR and CLD (or HCLD), with the CO₂ and NO values recorded as *b* and *c* respectively. The CO₂ shall then be shut off and only the NO span gas passed through the CLD (or HCLD) and the NO value recorded as *d*. Percent CO₂ quench shall be calculated as follows and shall not exceed 3 percent:

$$\% \text{ CO}_2 \text{ quench} = 100 \times \left(1 - \frac{(c \times a)}{(d \times a) - (d \times b)} \right) \times (a / b)$$

Where:

a = Undiluted CO₂ concentration (percent)

b = Diluted CO₂ concentration (percent)

c = Diluted NO concentration (ppm)

d = Undiluted NO concentration (ppm)

(2) *NO_x analyzer water quench check.*

(i) This check applies to wet measurements only. An NO span gas having a concentration of 80 to 100 percent of full scale of a normal operating range shall be passed through the CLD (or HCLD) and the response recorded as *D*. The NO span gas shall then be bubbled through water at room temperature and passed through the CLD (or HCLD) and the analyzer response recorded as *AR*. Determine and record the bubbler absolute operating pressure and the

bubbler water temperature. (It is important that the NO span gas contains minimal NO₂ concentration for this check. No allowance for absorption of NO₂ in water has been made in the following quench calculations. This test may be optionally run in the NO mode to minimize the effect of any NO₂ in the NO span gas.)

(ii) Calculations for water quench must consider dilution of the NO span gas with water vapor and scaling of the water vapor concentration of the mixture to that expected during testing. Determine the mixture's saturated vapor pressure (designated as *Pwb*) that

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corresponds to the bubbler water temperature. Calculate the water concentration ($Z1$, percent) in the mixture by the following equation:

$$Z1 = 100 \times \frac{P_{wb}}{GP}$$

where

GP = analyzer operating pressure (Pa)

(iii) Calculate the expected dilute NO span gas and water vapor mixture concentration (designated as $D1$) by the following equation:

$$D1 = D \times \left(1 - \frac{Z1}{100} \right)$$

(iv)(A) The maximum raw or dilute exhaust water vapor concentration expected during testing (designated as Wm) can be estimated from the CO_2 span gas (or as defined in the equation in this paragraph and designated as A) criteria in paragraph (c)(1) of this section and the assumption of a fuel atom H/C ratio of 1.8:1 as:

$$Wm(\%) = 0.9 \times A(\%)$$

Where:

A = maximum CO_2 concentration expected in the sample system during testing.

(B) Percent water quench shall not exceed 3 percent and shall be calculated by:

$$\% \text{Water Quench} = 100 \times \frac{D1 - AR}{D1} \times \frac{Wm}{Z1}$$

[59 FR 31335, June 17, 1994. Redesignated and amended at 63 FR 56995, 57011, Oct. 23, 1998; 63 FR 58101, Oct. 29, 1998]

§ 89.319 Hydrocarbon analyzer calibration.

(a) The FID hydrocarbon analyzer shall receive the initial and periodic calibration as described in this section. The HFID used with petroleum-fueled diesel (compression-ignition) engines shall be operated to a set point $\pm 5.5^\circ C$ between 185 and 197 $^\circ C$.

(b) *Initial and periodic optimization of detector response.* Prior to introduction into service and at least annually thereafter, adjust the FID hydrocarbon analyzer for optimum hydrocarbon response as specified in this paragraph. Alternate methods yielding equivalent results may be used, if approved in advance by the Administrator.

(1) Follow good engineering practices for initial instrument start-up and basic operating adjustment using the appropriate fuel (see § 89.312(e)) and zero-grade air.

(2) Optimize the FID's response on the most common operating range. The response is to be optimized with respect to fuel pressure or flow. Efforts shall be made to minimize response variations to different hydrocarbon species that are expected to be in the exhaust. Good engineering judgment is

to be used to trade off optimal FID response to propane-in-air against reductions in relative responses to other hydrocarbons. A good example of trading off response on propane for relative responses to other hydrocarbon species is given in Society of Automotive Engineers (SAE) Paper No. 770141, "Optimization of Flame Ionization Detector for Determination of Hydrocarbon in Diluted Automotive Exhausts"; author Glenn D. Reschke. It is also required that the response be set to optimum condition with respect to air flow and sample flow. Heated Flame Ionization Detectors (HFIDs) must be at their specified operating temperature. One of the following procedures is required for FID or HFID optimization:

(i) The procedure outlined in Society of Automotive Engineers (SAE) paper No. 770141, "Optimization of a Flame Ionization Detector for Determination of Hydrocarbon in Diluted Automotive Exhausts"; author, Glenn D. Reschke. This procedure has been incorporated by reference at § 89.6.

(ii) The HFID optimization procedures outlined in 40 CFR part 86, subpart D.